Ventilating Your Home

Introduction

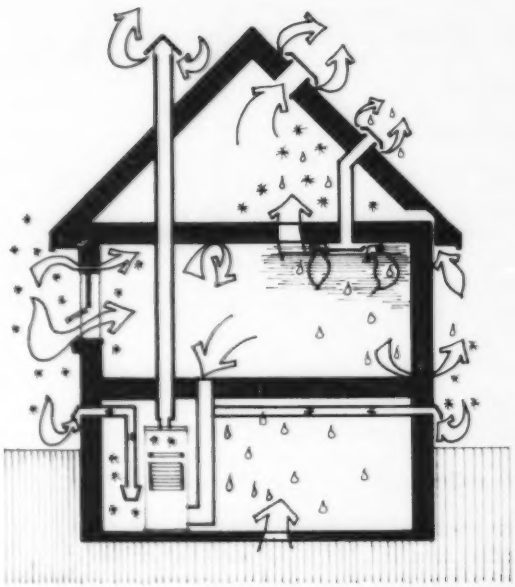
In the past, houses received enough fresh air through natural air leakage. In most cases we got more fresh air than we needed (especially at -30°F).

Since the early 1970s significantly increased fuel prices and the consequent pursuit of energy efficiency through tighter construction has led to a concern over adequate ventilation. Air sealing techniques, improved weatherstripping products, higher insulation levels and appliances with increased combustion efficiency have contributed to reduced heating bills and increased comfort. But, if a tightly sealed home does not have a well-designed mechanical ventilation system, problems such as unsafe operation of combustion appliances, condensation, odours and poor air quality can occur.

More recently, advances in construction techniques resulted in new homes that are well-sealed and have higher insulation levels. New higher-efficiency heating systems reduce air leakage by reducing chimney losses.

Air-sealing techniques and special construction methods have reduced heating bills and increased comfort. However, tightly sealed homes may result in unsafe operation of combustion appliances, condensation problems, or concentrations of air contaminants that may cause discomfort or impair health.

This publication will increase your understanding of ventilation and help identify existing or potential problems.



Unplanned ventilation can be a problem

Problems can be solved by carefully controlling the movement of indoor and outdoor air within the house. **The exchange of indoor and outdoor air is called ventilation.** The term **natural ventilation** describes air exchange occurring without the use of mechanical devices. This can be through unintentional openings (air leakage through cracks) or through intentional openings (operable windows or fresh air ducts). **Mechanical ventilation** refers to air exchange created by electric exhaust and intake fans.

Attic ventilation is not discussed here as it does not significantly affect indoor air quality. For detailed information see *Attic Insulation*.

Understanding New Terminology

This section describes the terms used here. (Figure 1)

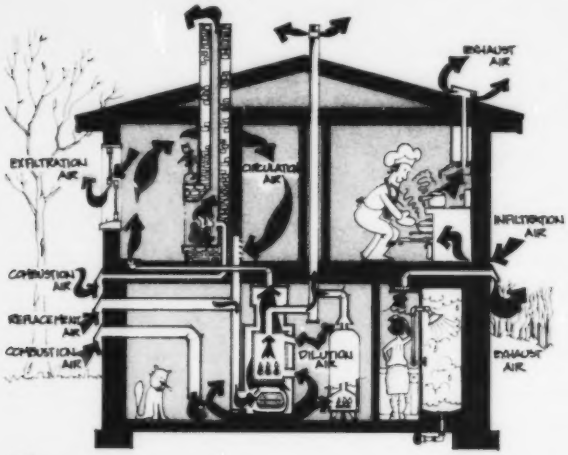


Figure 1

Air Change Rate

The rate at which air inside the house is replaced by outside air through a combination of natural and mechanical ventilation. For example, an air change rate of one-half air change per hour (ACH) means that half the volume of air in the house is exhausted and replaced by fresh air each hour.

Circulation Air

Indoor air that is moved around the house by a circulating fan as in forced air heating systems.

Combustion Air

The air required to allow fuel to be burned efficiently and safely in appliances such as furnaces, water heaters and fireplaces.

Dilution Air

The air required by standard efficiency combustion appliances to maintain an effective chimney draft regardless of atmospheric pressure fluctuations or weather conditions.

Exhaust Air

Air expelled outdoors by bathroom and kitchen fans, clothes dryers, power vacuums, etc.

Exfiltration

The uncontrolled leakage of indoor air out of the house through cracks around windows, doors, electrical outlets and other openings such as the chimney.

Infiltration

The uncontrolled leakage of outdoor air into the house through cracks around windows, doors, electrical outlets and other openings.

Replacement Air

Outdoor air that replaces the air removed from the house by dilution air, exhaust air and exfiltration. It is usually supplied by controllable fresh air inlets intentionally installed in the home or by random infiltration.

Ventilation Concerns

Humidity and Odours

Humidity and odours can be annoying and unhealthy when present in excessive amounts. Over time, high indoor relative humidity can cause serious structural problems with wood rot and damage to other building materials as well as respiratory problems from molds and dustmites. When odours linger or excessive condensation accumulates on windows, it may be an indication that the house is not receiving an adequate supply of fresh air.

Solutions to moisture problems are detailed in *Condensation Concerns*. Try the simple steps first to solve condensation problems. They usually are low cost.

It is important to understand that houses with condensation problems do not necessarily have a ventilation problem. There are causes for condensation other than lack of ventilation, such as inadequate insulation, poor window glazing or worn weatherstripping. Conversely, solving a condensation problem does not mean there is no ventilation problem.

Figure 2

Indoor Air Pollutants

Identifying the Problem

Our indoor environment has changed. Questions are now being asked about possible adverse effects of lower air leakage and the health of occupants. A number of factors cause problems.

- Sources within the house may create high pollutant levels.
- Ventilation may not be sufficient to remove the pollutants.
- Poor air circulation results in localized areas of high pollutant concentrations.

Too low or too high a relative humidity can lead to respiratory problems.

A house can be contaminated in a variety of ways. Formaldehyde is given off by some building materials and furnishings. Radon can enter from surrounding soil or groundwater or be emitted from certain masonry building products. The incidence of radon in Alberta is low. Other pollutants are added to indoor air from various sources (Figure 2). Carbon monoxide from incomplete burning or malfunctioning stoves or furnaces are serious health hazards. Some sources and health effects of pollutants are described in Table 1.

Table 1

Indoor Air Pollutants

Pollutant	Possible Source	Health Effect
Benzo(a)pyrene	Fireplaces, woodstove, tobacco smoke	Can cause coughing, headaches, nausea, and irritation to eyes, nose and throat. Also known to cause lung cancer.
Carbon dioxide	Humans, animals, improperly operating gas appliances, kerosene heaters	High concentrations reduce the flow of blood to the brain and can cause headaches, nausea and dizziness.
Carbon monoxide	Tobacco smoke, improperly operating gas appliances, kerosene heaters, malfunctioning furnaces, fireplaces	Symptoms include headaches, mental confusion, dizziness, impaired vision and fainting on exertion. At high levels unconsciousness and death can occur.
Formaldehyde	Particleboard, plywood, carpet backing furnishings, insulations, tobacco smoke	Can produce eye, nose and throat irritation, coughing, headaches, dizziness, nausea, vomiting and nose bleeds
Nitrogen oxides	Kerosene heaters, woodstoves and fireplaces, malfunctioning furnaces, tobacco smoke, improperly operating gas appliances	Causes irritation of mucous membranes of upper respiratory tract. Prolonged exposure can cause lung damage
Radon	Soil, ground water, rock, concrete	Radioactive radon particles attached to dust can become trapped in the lungs and cause cancer.

Use this table carefully. Although the sources produce various pollutants, high concentrations may not necessarily result. If you or your family show signs of the health effects listed refer to the next section, "Solutions". If the health effects persist, seek medical advice.

Long-term health effects of exposure to low levels of pollutants are not well documented and it is difficult to establish safe concentrations. Until more research is complete, it is wise to try to reduce pollutant levels.

Solutions

Two ways to control indoor air pollutants are to stop them at the source or to ventilate. Limit the production of air pollutants using the following methods:

- Formaldehyde levels can be reduced by selecting chemically stable building materials. Limit the use of glues and interior grade plywood and particleboard (which use ureaformaldehyde resin). If particleboard must be used, such as in cabinets, be sure it is well-sealed to prevent the escape of gases.
- Radon infiltration can be kept to a minimum by sealing cracks in the basement, and in new homes by installing a layer of polyethylene plastic under the basement floor before the concrete is poured.

Floors of ceramic tile or solid hardwood finished with a wax or polyurethane can replace carpet to help control formaldehyde levels.

- Nitrogen oxides and carbon monoxide can be kept at safe levels by limiting the use of unvented or improperly operating combustion appliances.
- Fireplaces and woodstoves are common sources of benzo(a)pyrene, so be sure they are installed with airtight glass doors, a flue damper that seals well and their own outdoor combustion air supply. Install glass doors and an outdoor combustion air supply to existing fireplaces.
- Maintain and adjust all combustion appliances to ensure they are operating safely and efficiently.
- Reduce polluting activities such as tobacco smoking. This helps control levels of benzo(a)pyrene, nitrogen oxides, formaldehyde and carbon monoxide.
- Reduce your reliance on toxic cleaning products and eliminate the use of aerosols.

If attempts to reduce the contaminant at the source are not sufficient to control indoor pollutant levels, it may be necessary to increase ventilation rates. Ventilation options are discussed later.

Backdrafting

Identifying the Problem

Many devices require large quantities of indoor air to function properly. On a cold winter day, a home with a conventional furnace and hot water tank would use 760 000 litres per day (27 000 cubic feet per day) of house air for combustion and dilution air. A large fireplace might exhaust that same volume of air in three hours when burning rapidly. Significant amounts of indoor air can also be vented outdoors by clothes dryers and bathroom and kitchen fans. This means that an entire volume of house air could be removed in less than an hour.

Have you considered how this large volume of air is replaced? In the past, infiltration usually provided combustion and replacement air to balance the quantity exhausted outdoors. However, if the home is tight enough to restrict air flow without proper ventilation devices that require house air to compete with each other. This results in a serious problem called **backdrafting**.

Imagine you have put a load of clothes in the dryer and sit down to relax in front of the fireplace on a cold winter night. House air is being drawn up the fireplace chimney and out the dryer vent and there may not be sufficient air infiltrating into the house to replace it. This creates a lower indoor pressure relative to the outside and air will be drawn into the house through the most convenient route. **The furnace chimney may become an air supply route (Figure 3). If the furnace comes on and cannot reverse this backdraft condition, combustion gases that would normally go up the furnace chimney will escape into the house through the draft hood of the furnace or water heater.**

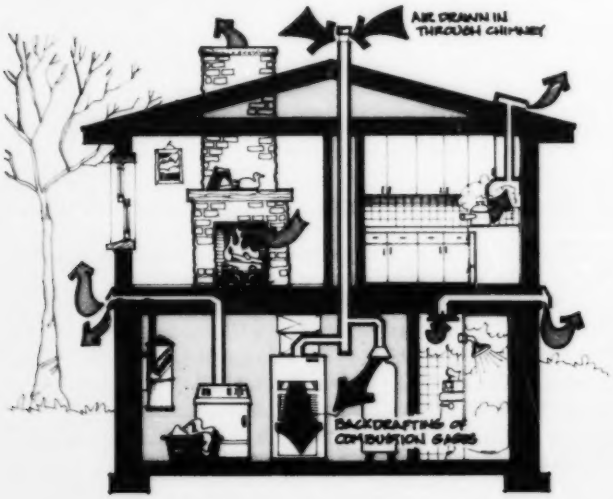


Figure 3

Research indicates that backdrafting can be a common occurrence in many homes and a potential problem in others.

There are indicators that will help you determine if backdrafting is occurring:

- Inspect your furnace and hot water heater for the following signs (Figure 4):

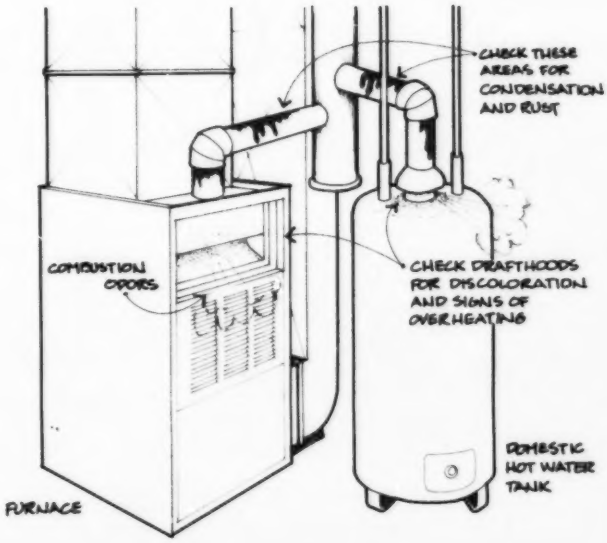

CHECK THESE AREAS FOR CONDENSATION AND RUST
COMBUSTION ODORS
CHECK DRAFTHOODS FOR DISCOLORATION AND SIGNS OF OVERHEATING
DOMESTIC HOT WATER TANK
FURNACE

Figure 4

  - Combustion odours near these appliances particularly when they have just started up.
  - Heavy sooting, discoloration or burnt areas around the draft hoods.
  - Condensation and rust around the vents to the chimney. Check in cold weather when the furnace has not been running for some time.
- Problems such as high humidity and stale indoor air or odours can also be attributed to a malfunctioning chimney.
- Physical ailments caused by combustion products, such as carbon dioxide and carbon monoxide include headaches, nausea, coughs and stinging eyes. Serious backdrafting can cause enough combustion gases to be vented in to cause unconsciousness and death.

Solutions

Backdrafting should be corrected immediately because of the health hazards. Assistance is available. Your gas company may have an inspection service or can direct you to qualified service personnel. The Plumbing and Gas Safety Services Branch of Alberta Labour may also provide assistance especially if the problem is a faulty appliance or unsafe installation. Finally, you can contact a heating contractor qualified to service your furnace.

Qualified technicians will inspect the chimney and venting system for damage or blockage and conduct an appliance backdraft test. If your furnace or water heater are backdrafting you must increase supplies of combustion and replacement air. This is done by installing a separate insulated fresh air duct from outside to provide combustion air for the furnace and hot water heater (Figure 5). This duct should not have a manual damper. However it must be located within one foot vertically and two feet horizontally of the burners on the largest appliance, usually the furnace. To avoid dumping of cold air through this duct it should be fitted with a container or be equipped with an approved automatic damper or diffuser. An insulated fresh air duct from the outdoors to the return air plenum of a forced-air heating system is also installed to provide air for other appliances and vents. This installation is required by the Alberta Building Code.

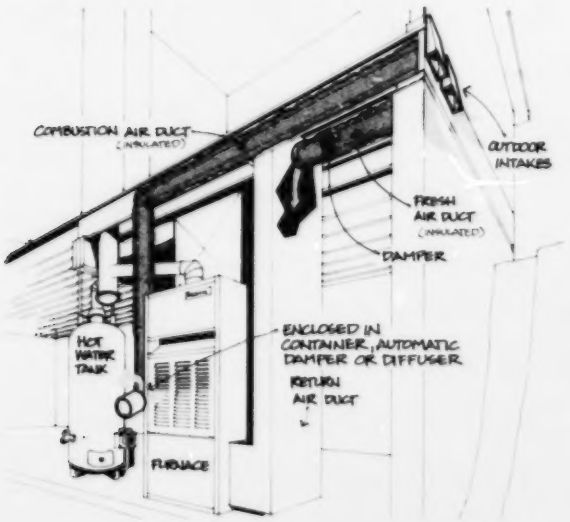


Figure 5

If the fireplace is backdrafting, it should be equipped with airtight glass doors and its own supply of outdoor combustion air. Some fireplaces are not designed to be used with glass doors so consult a fireplace dealer and your local heating inspector before installation.

Choosing a Ventilation System

Alberta ventilation standards are established in the Alberta Building Code. The code requires that the entire house have a mechanical ventilation system capable of providing at least one-third an air change per hour. This is equivalent to 42 litres per second (l/s) or 89 cubic feet per minute (cfm) in a 1000 square foot bungalow.

The system should also satisfy the following performance requirements.

- **Supply each room with a continuous supply of fresh air, at a rate of about 5 l/s (10 cfm).** Higher ventilation rates are needed for kitchens and bathrooms: 25 l/s (50 cfm) to bathrooms and 50 l/s (100 cfm) to kitchens on an intermittent basis.
- **Distribute fresh air to every room.** In homes with a forced air system, this can be done by running the furnace fan continuously at a low speed.
- **Meet minimum comfort requirements.** Cold outside air should not be dumped into the living space but be tempered or mixed to prevent drafts or cold spots.
- **Not affect the operation of the combustion appliances.** It is not enough to exhaust stale air and expect air infiltration to replace it with fresh air. If air is drawn out faster than it can be replaced, negative indoor pressure will be created and backdrafting occurs.
- **Be controllable.** Controls may be manual (such as adjustable dampers) or automatic (such as override switches or humidity controllers like dehumidistats).

A variety of systems and techniques for ventilating the home are examined here.

Passive Systems

Passive ventilation systems operate without use of fans. An open window is an example. Open windows, however, are not practical on cold, windy, winter days and they will not provide a constant ventilation rate. The turbine ventilator and associated ductwork is another device that provides passive ventilation, but also cannot provide a constant ventilation rate and there is no control over the distribution of fresh air.

Another method of passive ventilation is to bring fresh air in through an open fresh air duct (Figure 5), as part of the solution to backdrafting. This will be effective only if there is a significant amount of exhaust elsewhere, such as vents that open to positive pressure.

Exhaust-Only Systems

An exhaust-only system uses fans to remove stale air from the house. This creates a negative pressure indoors and causes fresh outdoor air to be drawn into the home through infiltration or intentional inlets. Kitchen and bathroom exhaust fans are simple exhaust-only ventilation systems.

In older homes exhaust fans can be installed in high humidity areas like the bathroom, kitchen and laundry room. It is best to install the fans on interior walls, vented through ducts down the wall cavity and out through the joist space (Figure 6). This inhibits warm air leaking up the duct and eliminates duct condensation and dripping. Make sure the exhaust fans are powerful enough to move the air the distances required. If vents must be installed through the attic space, they should be insulated and well-sealed so that warm, moist air cannot leak into the attic space.

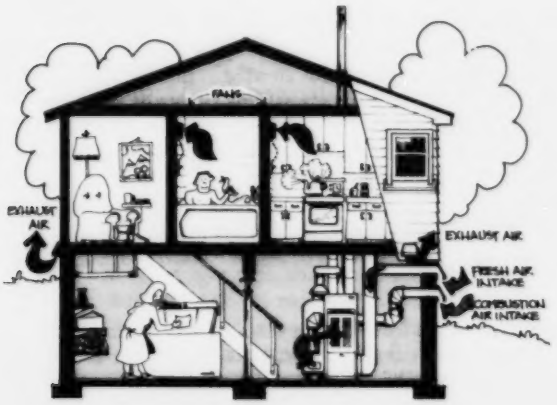


Figure 6

For continuous ventilation, a single, centrally located fan can be installed to draw exhaust air from high moisture areas such as the kitchen or bathroom. The fan should be controlled by a dehumidistat which will turn the fan on or increase its speed when humidity levels rise above a set limit.

An improvement on this is an exhaust-only ventilation system which circulates air continually and expels humid air outside only when necessary (Figure 7). Its operation is controlled by a dehumidistat. More elaborate control systems such as those described under heat recovery ventilators can also be used.

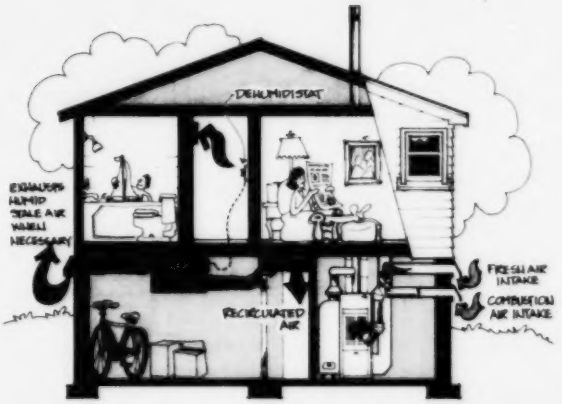


Figure 7

With any exhaust-only ventilation system, the potential for lower indoor pressure increases the risk of backdrafting. Therefore, adequate combustion and replacement air must be provided through other openings such as fresh air ducts. These systems should not be used in homes insulated with ureaformaldehyde foam insulation (UFFI) as formaldehyde gas can be drawn into the house.

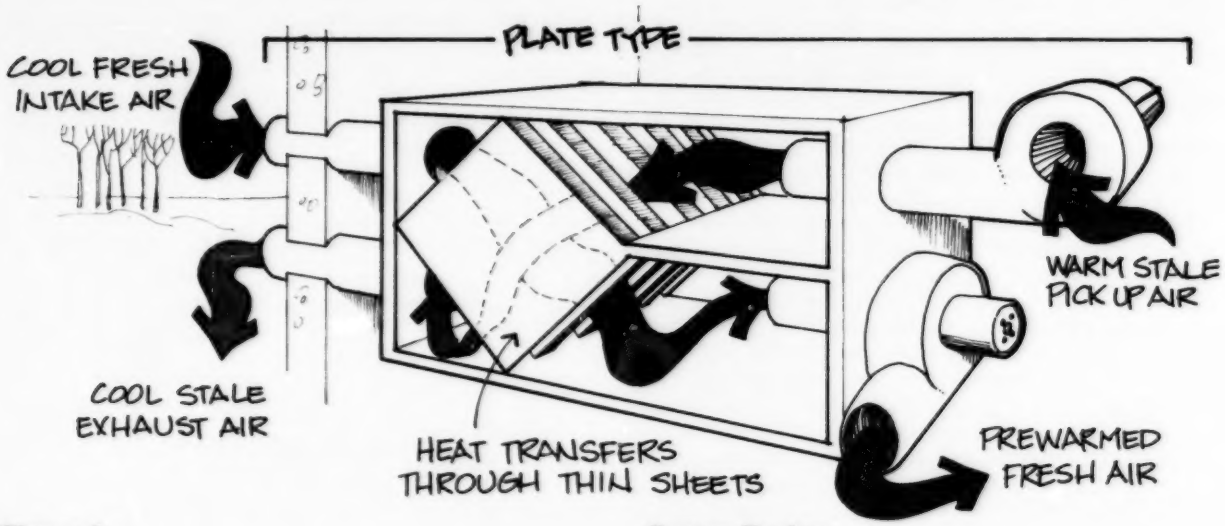


Figure 8

Heat Recovery Ventilators

How They Work

To reduce heating bills that accompany ventilation in cold weather attention is being focused on heat recovery ventilators, commonly known as air-to-air heat exchangers.

Figure 8 shows how a heat recovery ventilator works. A fan draws warm, humid, stale air from the house and passes it through the core of the unit. Heat from the warm air is transferred through thin sheets or pipes before the air is exhausted outside. At the same time, another fan draws in an equal amount of cool, dry, fresh air from outdoors through the core where it picks up the heat lost from the outgoing air. This pre-warmed incoming air is then distributed throughout the house.

In order to keep outgoing and incoming air streams separated so that the fresh air will not be contaminated, each heat recovery ventilator contains a heat exchange core.

System Design

Most heat recovery ventilators use ductwork to move air. The ducting layout and venting arrangement is essential to attain good air mixing. Ideally, the ventilator should draw stale air from, and distribute fresh incoming air to, all parts of the house. In practice the situation is rarely ideal. If your house is an open design with few partition walls, air mixing will generally be good. Homes with many rooms have poorer circulation and may require extra ductwork to achieve adequate air movement.

In homes with forced air systems, the furnace fan and ducts are commonly used to distribute fresh air (Figure 9). Stale air pickup ducts, separate from the heating system, draw air into the ventilator from the kitchen, utility rooms and bathrooms, which produce most of the moisture, pollutants and odours. The kitchen stale air pickup is separate from the range hood exhaust fan to prevent cooking grease and smoke fouling the heat exchanger core.

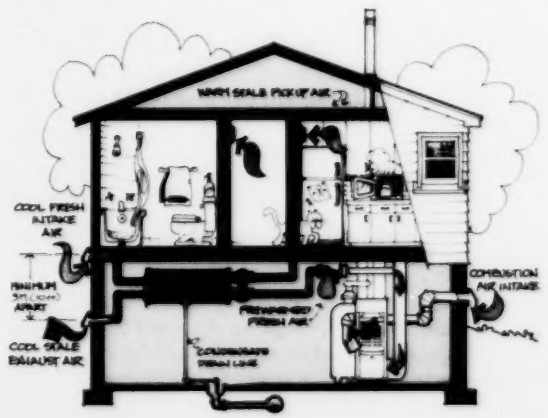


Figure 9

Venting the clothes dryer or kitchen range hood exhaust directly into the ventilator is not approved by the Canadian Standards Association. All clothes dryers and ranges should be exhausted directly outdoors.

The fresh air intake line from outdoors to the ventilator and the stale air exhaust line from the ventilator to outdoors are run through the floor header joist to exterior hoods, much like dryer vents. The ventilator is placed close to an outside wall, when possible, to keep the two ducts short. The ductwork will be cold and should be insulated and wrapped in a vapour barrier to prevent condensation and conduction of heat out of the house. Outside, it is wise to separate the exhaust port from the intake port by at least 3m (10 ft) to prevent cross-contamination of the incoming fresh air with pollutants from the exhaust air. The vents must be placed a minimum of 460mm (18 inches) above snow level to prevent blockage. Try to place the fresh air intake on a side of the house away from traffic exhaust or road dust.

To distribute pre-warmed air throughout the house using a forced air heating system, the supply air duct from the ventilator empties into the house between 10 and 30 cm (4 to 12 inches) from a return air grille. There must not be a direct connection between the ventilator supply and the forced air system. If the ventilator is connected directly, changes in speed of the furnace fan can cause an imbalance between the supply and exhaust air flow through the ventilator. If the fresh air supply pick-up register is located near the furnace be sure it is outside the furnace room. For fresh air to be distributed, the furnace fan must run whenever the ventilator is on. This is best accomplished by running the furnace continually on low speed.

In houses with radiant heating systems, additional ductwork must be installed to distribute the prewarmed fresh air--much like a small forced air system. Fresh air is supplied to the living rooms and bedrooms while the exhaust air is drawn from the kitchen, bathroom and laundry areas. It is best to locate supply lines in non-sitting areas or above baseboard heaters because incoming air will be cool. Supply lines may also be placed near the ceiling where cool air will mix with warm air at the ceiling.

Combustion and replacement air must be supplied separately. The heat recovery ventilator replaces only the stale air it removes and will not provide for any other air requirements.

Controls

Humidity measurement is the most practical method to control the operation of the heat recovery ventilator. It would be more effective to provide control based on both humidity and pollutants. Inexpensive, effective air pollutant analyzers are not yet commercially available. An example of how a control system could be connected is shown in Figure 10.

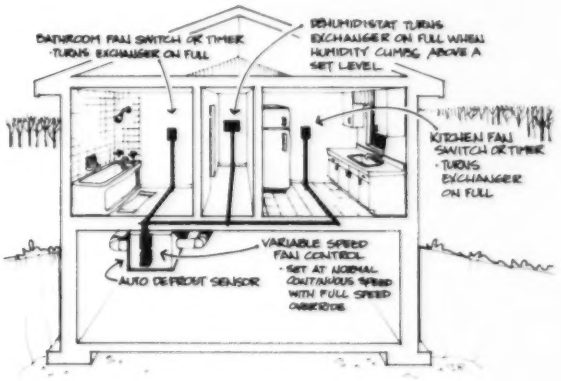

BATHROOM FAN SWITCH OR TIMER
· TURNS EXCHANGER ON FULL
DEHUMIDISTAT TURNS EXCHANGER ON FULL WHEN HUMIDITY CLIMBS ABOVE A SET LEVEL
KITCHEN FAN SWITCH OR TIMER
· TURNS EXCHANGER ON FULL
VARIABLE SPEED FAN CONTROL
· SET AT NORMAL CONTINUOUS SPEED WITH FULL SPEED OVERRIDE
AUTO DEFROST SENSOR

Figure 10

These guidelines should be considered when selecting controls:

- Install timer switches in bathrooms and kitchen. When switches are turned on, ventilator fans are boosted to high speed for the period set on the timer. This is an effective method to provide peak ventilation. Manual wall switches will also work but must be conscientiously shut off when high speed ventilation is no longer necessary.
- Install a dehumidistat in a central location away from fresh air outlets. Choose an area of average humidity and, if possible, locate it near the thermostat. The ventilator fans operate at low speed when the humidity is below a set point, say 40 per cent. The dehumidistat automatically boosts fans to high speed when humidity climbs higher. When humidity falls below 40 per cent the fan reverts to low operating speed.
- Be sure the ventilator has a variable speed control to regulate normal fan operating speed so that the continuous low speed setting can be adjusted easily to suit your lifestyle.

Selection and Installation Guidelines

When choosing a heat recovery ventilator check the following:

- The ventilator should have the capacity to exchange at least one-third the total volume of air in your house every hour. A 1000-square-foot house is equivalent to 42 l/s (89 cfm). The ventilator capacity will need to be greater than this to overcome resistance of the ductwork.
- It should have a variable speed control with manual override or a dehumidistat to adjust operation to the needs of the house.
- A defrost mechanism to melt frost or ice that may build up inside the heat exchanger core during cold weather is essential.
- It should have easy access to clean the core which accumulates dust and dirt. Regular cleaning is necessary to maintain heat exchange efficiency and indoor air quality.
- Ductwork must have filters to clean the air. Filters are placed on the incoming fresh air and the stale air pickup lines and they must be cleaned or replaced regularly like furnace filters.

Choosing an installer for your heat recovery ventilator must also get careful consideration. Many problems associated with ventilators can be prevented if installed according to the standards of the Canadian Standards Association. Based on these standards, the Heating, Refrigeration and Air Conditioning Institute of Canada provides a course to instruct and certify installers. Check that your installer has received this training.

Summary

- Become familiar with the ventilation requirements of your house.
- See if you have problems caused by inadequate ventilation. Check for:
  - Prolonged condensation on your windows in winter
  - Symptoms of health problems that may be a result of indoor pollutants
  - Signs of backdrafting
- Decide on the proper solution:
  - Turn the humidifier off
  - Install a fan in the kitchen
  - Eliminate pollutant sources
  - Install a combustion air line to the furnace
  - If necessary, choose an appropriate ventilation system.

Providing adequate ventilation makes sense. You will be able to control your indoor environment and maintain a fresh, healthy atmosphere.

Revised 1990

Distribution of this publication by commercial firms does not imply provincial government approval or endorsement for products or services offered for sale.

Individual copies of this publication are available at no charge within the province.

ISBN: 0-86499-194-0

Energy MATTERS

Ventilating Your Home

For information on other energy conservation topics, call our toll-free line:

Dial 0 and ask for ZENITH 22339
(Edmonton 427-5300)

or write:
Alberta Department of Energy
Energy Efficiency Branch
2nd Floor, Highfield Place
10010-106 Street
Edmonton, Alberta
T5J 3L8

Publications Available in this Series

Basement Insulation
Caulking and Weatherstripping
Heating Systems
Attic Insulation
Condensation Concerns
Windows
Ventilating Your Home
Water and Electricity
New Homes
Passive Solar
Wood Heating
Crawlspace Insulation
Storey-and-a-half Insulation
Cool Rooms

Alberta
ENERGY
Energy Efficiency Branch

recycled paper

Alberta Energy $avers – One of a Series